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INFLUENCE OF PACKAGING AND STORAGE TEMPERATURES ON THE POSTHARVEST PHYSICO-CHEMICAL PARAMETERS OF ARILS OF POMEGRANATE CV. GANESH

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ABSTRACT

An experiment was conducted on arils of Ganesh cultivar on physico-chemical properties by using different packaging and storage temperatures. Arils packed in polypropylene modular mate (PPMM) (P_3) recorded the minimum physiological loss in weight (PLW) (2.44%) with high TSS (14.78°Brix), acidity (0.37%), per cent total sugar (9.75) and ascorbic acid (7.93 mg $100g^{-1}$). With respect to storage temperatures, arils stored at 1°C (S_1) recorded minimum PLW (1.80%) with high TSS (15.01°Brix) and acidity (0.40%), per cent total sugar (9.90), ascorbic acid content (8.27 mg $100g^{-1}$). The interaction effects between packing material and storage temperatures, revealed that the minimum PLW (1.33%) coupled with high TSS (15.17°Brix), acidity (0.42%), per cent total sugar (10.56), ascorbic acid content (8.74 mg $100g^{-1}$), were observed in PPMM + 1°C (P_3S_1)

KEYWORDS: Arils, Packaging Material & Storage Temperature

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Original Article

INTRODUCTION

Pomegranate (Punica granatum L.) regarded as "Fruit of Paradise" is one of the most adaptable subtropical minor fruit crops. In India, it is regarded as a "vital cash crop", grown in an area of 150,000 ha with a production of 1,100,000 tons. Among the different states growing pomegranate, Maharashtra is the largest producer occupying 2/3rd of total area in the country followed by Karnataka, Andhra Pradesh, Gujarat and Rajasthan. Karnataka State has the distribution of cultivating pomegranate under tropical conditions in an area of 12,042 ha with a production of 129,547 tons. Pomegranate fruit is a non-climacteric fruit with relatively low respiration rate and produces trace amounts of ethylene (Caleb *et al*. 2012). The demand for minimally processed pomegranate arils (ready-to- eat arils) is increasing in domestic as well as international markets, because of high economic importance, healthiness and their desirable characteristics as compared to whole pomegranate fruit and changing food consumption pattern. In order to meet the consumers present demand for natural, fresh, flavors, convenient and high quality ready-to- eat pomegranate arils, various processing techniques have been developed among which packaging material have importance. So the present research work was undertaken.

MATERIAL AND METHODS

The experiment was conducted at Post-Harvest Technology Laboratory, College of Horticulture (COH),

Anantharajupet, YSR Kadapa district, Andhra Pradesh during the year, 2015. The fruits of pomegranate varieties, namely, Bhagwa used in the experiment were obtained from AICRP centre on Arid Zone fruits, Horticultural Research Station, Rekulakunta, Ananthapuramu district, Andhra Pradesh. The experiment was conducted in a completely randomized design replicated thrice with 3 packaging materials viz., PESP (P_1), PETP (P_2) and PPMM (P_3) and storage temperatures S_1 (1°C), S_2 (4°C), S_3 (8°C) and S_4 (room temperature). The following shelf life parameters were analyzed statistically and the results were presented.

Physological Loss in Weight

For determining the Physiological loss in weight (PLW) (%), arils was weighed before imposing the treatment and noted as the initial weight. The loss in weight was recorded in four days interval up to sixteen days, which served as the final weight.

TSS

The Total soluble solids (TSS) (°Brix) content of arils was determined by ERMA hand refractro-meter. A drop of juice obtained from arils was placed on prism of the refractro-meter and observed the coincidence of shadow of the sample with the reading on the scale and expressed as °Brix (Ranganna, 1986).

Titratable Acidity

Titratable acidity (%) of pomegranate juice was determined by the method, proposed by Ranganna (1986). In this method, 5ml of water was added to 5mlaril juice and mixed thoroughly. The sample solution was titrated against 0.1N NaOH is using phenolphthalein as indicator. Appearance of light pink color denotes the end point. The acidity of aril juice was expressed in per cent.

Total Sugars

The total sugars (%) were estimated by the A.O.A.C method (1980). Ten ml of pomegranate aril juice was taken into 100ml conical flask and 10 ml of distilled water was added. Five ml of 6N HCl was added to the contents and kept in a hot water bath at 70°C, for exactly eight minutes. After that, the flask was removed from the water bath and cooled to room temperature. The excess acidity was neutralized by adding 40% sodium hydroxide to the conical flask using phenolphthalein as indicator. This was indicated by the formation of pink colour. Then the solution was made up to 100ml by using distilled water and then filtered. The filtrate was taken into a burette and titrated against 10 ml of Fehling solution (5ml of both A and B) in hot condition using methylene blue as an indicator and continued the titration till the brick red colour precipitate is formed. Titre value was noted and the percentage of total sugar was estimated by using the factor, 10ml of Fehling solution = 0.05g glucose.

Ascorbic Acid

Ascorbic acid (mg $100g^{-1}$) was estimated as per the procedure, outlined by Ranganna (1986). Ten grams of pomegranate arils juice were taken in a 100 ml volumetric flask and the volume was made up with 3 % Meta phosphoric acid. Ten millilitre of the aliquot was taken and titrated with standard dye (2, 6, dichlorophenol indophenol dye) until it attains pink red. The ascorbic acid was estimated and expressed as mg ascorbic acid 100 g^{-1}.

Statistical Analysis

The data collected were analyzed statistically using factorial completely randomized design as per the procedure outlined by Pence and Sukhatme (1985) and valid conclusions were drawn only on significant differences between treatments mean at 0.05 per cent level of significance.

RESULTS AND DISCUSSIONS

The data revealed that there was an increase in PLW (%) of pomegranate arils as the storage period increased. Lowest PLW (%) of arils was recorded in PPMM (P_3) (0.73, 1.32, 1.82 and 2.44) and highest PLW (%) was recorded in PETP (P_2) (1.65, 2.51, 3.25 and 3.80) during the storage period of 4, 8, 12 and 16 days respectively. The arils packed in PPMM (P_3) recorded less PLW (%) compared to other treatments might be due to reduced rate of respiration as reported by Nanda *et al.* (2001) and Bhatia *et al.* (2013). With respect to storage temperatures, 1°C (S_1) recorded less PLW (%) (0.32, 0.63, 1.03 and 1.80), whereas, room temperature (S_4) was recorded more PLW (%) in (2.59, 4.03, 4.85 and 5.50) during the storage period of 4, 8, 12 and 16 days, respectively. The continuous increase in PLW with the increase in storage period at all storage conditions could be due to loss of moisture from the arils through respiration and transpiration resulting into reduction in moisture content of pomegranate arils. The less PLW (%) of arils in S_1 could be attributed to less moisture loss due to minimum metabolic activities like respiration and transpiration at low temperatures. A similar result was also recorded by Khude (2012) and Phutankar *et al.* (2014) in jackfruit. Significant variation in PLW (%) of pomegranate arils was observed with interaction of storage treatments and storage conditions Significantly lowest PLW (%) of arils was observed in PPMM + 1°C (P_3S_1) (0.17, 0.28, 0.72 and 1.33) and the highest PLW (%) of arils was observed in PETP and room temperature (P_2S_4) (4.08, 4.97, 6.05 and 6.33) during the storage period of 4, 8, 12 and 16 days respectively. The findings are in line with findings of Sandhu and Singh (2000) in pear, Nanda *et al*. (2001) and Bhatia *et al*. (2013) in pomegranate.

The data pertaining to TSS (°Brix) of arils recorded significant variation with respect to packing material and storage temperatures. The minimum TSS (°B) was recorded in arils packed in PPMM (P_3) (15.41, 15.58 and 15.69) whereas, maximum TSS (°B) was recorded in arils packed in PETP (P_2) (15.58, 15.87 and 15.89) at 4th, 8th and 12th day of storage, respectively. However, on the 16th day, the maximum TSS was observed in P_3 (14.78 °B) and minimum TSS in P_2 (14.56 °B). With regard to storage temperatures, 1°C (S_1) recorded the lowest TSS (°Brix) (15.21, 15.33 and 15.40) and room temperature (S_4) recorded the highest TSS (°Brix) (15.92, 16.26 and 16.41) during 4th, 8th and 12th day of storage. On the 16th day, the maximum TSS was observed in 1°C (S_1) (15.01 °B) while, minimum TSS was observed in room temperature (S_4) (14.18 °B). The interaction effect of packing material and storage temperatures on TSS (°B) of arils revealed that, no significant effect was observed on 4th and 8th day of storage. On the 12th day of storage, the lowest TSS (15.37 °B) was noticed in PPMM + 1°C (P_3S_1) and the highest TSS (16.32 °B) was noticed in PETP +room temperature (P_2S_4). On the 16th day maximum TSS was recorded in PPMM +1°C (P_3S_1) (15.17 °B) and minimum at PETP and room temperature (P_2S_4) (14.33 °B). It was observed from the data that, the TSS was found to increase initially and later on decreased as the storage period progressed. The increase in TSS during the initial stages may be attributed to the conversion of starches and other polysaccharides into sugars or increased respiration and transpiration, whereas, decrease in TSS at the end of storage might be due to higher rates of fermentation as evidenced by the development of off flavors in Kinnow mandarin, by Bhuller and Farmahan (1980).

Arils packed in PPMM (P3) showed highest per cent titratable acidity of 0.49, 0.46, 0.43 and 0.37and it was low

in PETP (P2) packed arils 0.43, 0.42, 0.37 and 0.32 on 4th, 8th, 12th and 16th day of storage respectively. Arils stored at different storage temperature showed significant variation, whereas, highest per cent titratable acidity was noticed in arils stored at 1°C (S_1) (0.51, 0.50, 0.47 and 0.40 on 4th, 8th, 12th and 16th day of storage respectively. The lowest per cent titratable acidity was noticed at room temperature (S_4) 0.41, 0.36, 0.32 and 0.28 on 4th, 8th, 12th and the 16th day of storage, respectively. The interaction effect of packing material and storage temperatures on per cent titratable acidity of arils showed significant variation on the 4th day, significantly highest per cent titratable acidity was recorded in PPMM + 1°C (P_3S_1) 0.53 while, lowest per cent titratable acidity was observed in PETP + room temperature (P_2S_4) 0.37. The interaction effect was non-significant, with respect to titratable acidity on 8th, 12th, and 16th day of storage. The decrease in titratable acidity with the increase in storage period was due to utilization of organic acids in the respiration process as opined by Singh *et al*. (1954) in mango and due to conversion of acids to sugars as indicated by Pool *et al*. (1972) in Grapes cv. Thompson seedless. The decreasing trend of titratable acidity was less in PPMM + 1°C (P_3S_1), this might be due to decreased hydrolysis of organic acids and subsequent accumulation of organic acids, which were oxidized at a slow rate, because of decreased respiration in pomegranate, similar in findings with Nazmy *et al*. 2012 in pomegranate modular mate pack. The decrease in percent titratable acidity in packaged materials might be due to higher CO_2 concentration in the packages (Vines and Obserbacher, 1961), which decreased the rate of respiration in grapefruit (Peteracek *et al*. 1998). Similar results were also reported by Hussain *et al*. (1982) in citrus and Nanda *et al*. (2001) in pomegranate.

The percent total sugars were significantly low in arils packed in PPMM (P_3) (11.67 and 12.08) on 4th and 8th day of storage, whereas, high per cent total sugars were recorded in PETP (P_2)packed arils 12.30 and 12.70 on 4th and 8th day. However, on 12th and 16th day of storage, the per cent total sugars were maximum in arils 10.36 and 9.75 packed in PPMM (P_3) and minimum in PETP (P_2) packed arils 9.88 and 8.93.With respect to storage temperatures, significantly lowest per cent total sugars was observed at 1°C (S_1) 11.21, 11.41 while, highest per cent total sugars was observed at room temperature (S_4) 12.93, 13.60 in arils on 4th and 8th day of storage respectively. Whereas, on 12thand 16th day, the higher per cent total sugar was observed at $S_1$10.88 and 9.90 and lower per cent total sugars was observed at S_4 9.12 and 8.61. The interaction effect of packing material and storage temperatures on per cent total sugar was non-significant on all the days of storage. The slow rate of increase in per cent total sugar might be due to slow physiological and metabolic changes, and also due to slow conversion of starch into sugars (Nanda *et al*. (2001) in pomegranate and Keditsu *et al*. (2003) in Khasi mandarin). The declining trend in total sugars at a later stage, due to utilization of sugars as a substrate in metabolic process was reported by Rocha *et al*. (2003), in apple cv. Jonagored.

Significantly the highest ascorbic acid content (mg 100g^{-1}) was observed in PPMM (P_3) (11.48, 9.81, 9.07 and 7.93 in arils on 4th, 8th, 12th and 16th day of storage respectively, while, lowest ascorbic acid content (mg 100g^{-1}) was recorded in arils packed in PETP (P_2) 10.17, 9.18, 8.05 and 7.35on 4th, 8th, 12th and 16th day of storage respectively. Among the storage temperatures, highest ascorbic acid content (mg 100g^{-1}) was recorded at 1°C (S_1) 12.61, 10.55, 9.15 and 8.27 whereas, lowest ascorbic acid content (mg 100g^{-1}) was recorded at S_4 (room temperature) 8.86, 8.25, 7.49 and 6.87 during the entire period of storage. There was no significant difference between the interaction effect of packing material and storage temperatures with respect to the ascorbic acid content of arils throughout the storage period. The ascorbic acid content in arils showed a general declining trend in all packing material and storage temperatures. However, the decrease was more pronounced at room temperatures as compared to other storage temperatures due to increased rate of metabolic activity. The decrease in ascorbic acid content of arils was less rapid in PPMM packaged arils stored at lower temperatures (S_1, S_2 and S_3) compared to room temperature (S_4) storage. This might be partly due to degradation of ascorbic acid

through oxidation, reduced enzymatic oxidation at low O_2 and high CO_2levels as reported by Valero and Serrano (2010) and Siddiqui *et al.* (2011) in Broccoli. Higher ascorbic acid content in arils stored at S_1 (1°C) might be due to its slow rate of degradation. Similar findings were observed by Ram *et al*. (1970) in Kagzi lime, Mahajan *et al*. (2005) in Kinnow mandarin, Singh and Rao (2005) in Papaya and Githiga (2012) in Mango under MAP.

CONCLUSIONS

This paper gives valuable information on the influence of different packing material and storage temperatures, on quality and shelf life. Arils packed in polypropylene modular mate (PPMM) and stored at temperature of 1°C recorded highest shelf life and less physiological loss in weight and also retained appreciable nutritional quality at the end of storage period of sixteen days.

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APPENDICES

Table 1: Effect of Different Packing Material and Storage Temperatures on Physiological Loss in Weight (PLW) (%) of Arils of Pomegranate Cv. Ganesh

PLW (%)																	
Storage Period (Days)																	
	0	4				8				12				16			
		P_1	**P_2**	**P_3**	**Mean**	**P_1**	**P_2**	**P_3**	**Mean**	**P_1**	**P_2**	**P_3**	**Mean**	**P_1**	**P_2**	**P_3**	**Mean**
S_1	0.0	0.26	0.54	0.17	0.32	0.41	1.21	0.28	0.63	0.92	1.44	0.72	1.03	1.49	2.59	1.33	1.80
S_2	0.0	0.51	0.90	0.28	0.56	0.85	1.92	0.51	1.09	1.13	2.51	0.97	1.54	1.67	2.85	1.64	2.05
S_3	0.0	0.85	1.10	0.69	0.88	1.13	1.95	0.97	1.35	1.51	3.00	1.44	1.98	1.90	3.44	1.85	2.39
S_4	0.0	1.90	4.08	1.79	2.59	3.59	4.97	3.51	4.03	4.33	6.05	4.15	4.85	5.26	6.33	4.92	5.50
Mean	0.0	0.88	1.65	0.73		1.49	2.51	1.32		1.97	3.25	1.82		2.58	3.80	2.44	
		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05	
P		0.12		0.34		0.08		0.22		0.04		0.12		0.06		0.19	
S		0.13		0.39		0.09		0.26		0.05		0.13		0.07		0.21	
P×S		0.23		0.68		0.15		NS		0.08		0.23		0.13		NS	

Table 2: Titratable Acidity (%) of Arils of Pomegranate Cv. Ganesh as Influenced by Different Packing Material and Temperatures

Titratable Acidity (%)																	
Storage Period (Days)																	
	0	4				8				12				16			
		P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean
S1	0.52	0.52	0.49	0.53	0.51	0.50	0.48	0.52	0.50	0.46	0.44	0.49	0.47	0.39	0.38	0.42	0.40
S2	0.52	0.50	0.47	0.51	0.49	0.47	0.44	0.49	0.47	0.43	0.40	0.46	0.43	0.36	0.33	0.39	0.36
S3	0.52	0.47	0.40	0.48	0.45	0.44	0.39	0.47	0.43	0.41	0.35	0.43	0.39	0.35	0.32	0.37	0.35
Table 2: Contd.,																	
S4	0.52	0.42	0.37	0.43	0.41	0.37	0.35	0.37	0.36	0.32	0.30	0.35	0.32	0.27	0.27	0.30	0.28
Mean	0.51	0.48	0.43	0.49		0.45	0.42	0.46		0.41	0.37	0.43		0.34	0.32	0.37	
Statistics		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05	
P		0.002		0.007		0.004		0.010		0.005		0.015		0.008		0.024	
S		0.003		0.008		0.004		0.012		0.006		0.017		0.009		0.027	
P×S		0.005		0.014		0.007		NS		0.010		NS		0.016		NS	

Table 3: Titratable Acidity (%) of Arils of Pomegranate Cv. Ganesh as Influenced by Different Packing Material and Temperatures

Titratable Acidity (%)																	
Storage Period (Days)																	
	0	4				8				12				16			
		P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
S_1	0.52	0.52	0.49	0.53	0.51	0.50	0.48	0.52	0.50	0.46	0.44	0.49	0.47	0.39	0.38	0.42	0.40
S_2	0.52	0.50	0.47	0.51	0.49	0.47	0.44	0.49	0.47	0.43	0.40	0.46	0.43	0.36	0.33	0.39	0.36
S_3	0.52	0.47	0.40	0.48	0.45	0.44	0.39	0.47	0.43	0.41	0.35	0.43	0.39	0.35	0.32	0.37	0.35
S_4	0.52	0.42	0.37	0.43	0.41	0.37	0.35	0.37	0.36	0.32	0.30	0.35	0.32	0.27	0.27	0.30	0.28
Mean	0.51	0.48	0.43	0.49		0.45	0.42	0.46		0.41	0.37	0.43		0.34	0.32	0.37	
Statistics		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05	
P		0.002		0.007		0.004		0.010		0.005		0.015		0.008		0.024	
S		0.003		0.008		0.004		0.012		0.006		0.017		0.009		0.027	
P×S		0.005		0.014		0.007		NS		0.010		NS		0.016		NS	

Table 4: Effect of Different Packing Material and Storage Temperatures on Total Sugars (%) of Arils of Pomegranate Cv. Ganesh

Total Sugars (%)																	
Storage Period (Days)																	
	0	4				8				12				16			
		P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean
S1	13.51	11.28	11.54	10.79	11.21	11.45	11.81	10.95	11.41	10.95	10.49	11.20	10.88	9.74	9.38	10.56	9.90
S2	13.51	11.45	12.00	11.36	11.61	11.81	12.30	11.81	11.97	10.42	10.21	10.72	10.45	9.38	9.20	10.07	9.55
S3	13.51	12.20	12.61	11.81	12.21	12.40	13.05	12.30	12.58	10.07	10.00	10.27	10.11	9.04	8.72	9.55	9.11
S4	13.51	13.05	13.05	12.71	12.93	13.51	14.02	13.28	13.60	9.26	8.82	9.26	9.12	8.57	8.43	8.82	8.61
Mean	13.51	12.00	12.30	11.67		12.29	12.79	12.08		10.17	9.88	10.36		9.18	8.93	9.75	
Statistics		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05	
P		0.06		0.16		0.05		0.15		0.05		0.15		0.04		0.12	
S		0.06		0.19		0.06		0.18		0.06		0.17		0.05		0.14	
P×S		0.11		NS		0.11		NS		0.10		NS		0.08		NS	

Table 5: Effect of Different Packing Material and Storage Temperatures on Ascorbic Acid Content (Mg 100 G^{-1}) of Arils of Pomegranate Cv. Ganesh

Ascorbic Acid Content (Mg $100g^{-1}$)																	
Storage Period (Days)																	
	0	4				8				12				16			
		P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
S_1	14.03	12.61	12.40	12.81	12.61	10.57	10.49	10.57	10.55	8.95	8.74	9.76	9.15	8.13	7.93	8.74	8.27
S_2	14.03	11.18	10.37	12.80	11.45	10.35	9.96	10.57	10.29	8.74	8.34	9.35	8.81	7.73	7.65	8.34	7.90
S_3	14.03	9.76	9.35	11.18	10.10	9.35	8.54	9.56	9.15	8.46	8.00	9.29	8.58	7.43	7.30	7.52	7.42
S_4	14.03	8.95	8.54	9.10	8.86	8.51	7.73	8.53	8.25	7.49	7.12	7.87	7.49	7.00	6.51	7.12	6.87
Mean	14.03	10.62	10.17	11.48		9.70	9.18	9.81		8.41	8.05	9.07		7.57	7.35	7.93	
Statistics		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05		S. Em±		CD@P=0.05	
P		0.16		0.47		0.21		0.62		0.12		0.35		0.16		0.45	
S		0.19		0.54		0.24		0.71		0.14		0.41		0.18		0.52	
P×S		0.32		NS		0.42		NS		0.24		NS		0.31		NS	

Table 6

P_1	-	PESP	S_1	-	1°C	P	-	Packing material
P_2	-	PETP	S_2	-	4°C	S	-	Storage temperature
P_3	-	PPMM	S_3	-	8°C	P×S	-	Interaction between packing material and storage temperature
			S_4	-	Room temperature			